

Bay Area Rapid Transit District

Study Guide for the Electronics Technician Pre-Employment Examination

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INTRODUCTION

The Bay Area Rapid Transit (BART) District makes extensive use of electronics technology to operate the many systems within the District. The revenue vehicles, train control systems, fare collection machines, and many other systems are electronic or electronically controlled. Due to the large number of electronic systems, a person seeking District employment as an electronics technician should have a broad background in basic electronics.

The Pre-employment Test screens applicants, who meet the minimum qualifications, for electronics basic skills and electronics knowledge. The basic skills and knowledge are prerequisites for BART's job training courses for hired Electronics Technicians. BART does not currently provide basic skills training to newly hired Electronics Technicians.

The written examination consists of two parts: the Basic Skills Assessment and the Extended Skills Assessment. The Basic Electronics Skills Assessment examines the breadth of an applicant's knowledge, covering many facets of electrical and electronic technology. The Extended Skills Assessment determines whether the applicant possesses specific knowledge or skills that the hiring department deems essential.

The Basic Skills Assessment covers three areas of Electronics Technology. These areas are:

- General Electronics Knowledge and Computational Skills
This section determines the applicant's knowledge of electronic components, and the applicant's ability to perform mathematical computations involving these components, without using a calculator.
- Identifying and Using Semiconductors and Operational Amplifiers
This section determines the applicant's knowledge of semi-conductor components and operational amplifier configurations, and the applicant's ability to analyze the behavior of simple circuits, given certain conditions.
- Basic Digital Electronics
This section determines the applicant's knowledge of digital electronic components, digital logic, Boolean Algebra, the terminology of microprocessor-based systems, and the applicant's ability to analyze the behavior of simple circuits, given certain conditions.

The Extended Skills Assessment consists of modules that have a narrow technical focus. The hiring departments select these modules to examine skills directly applicable to a specific Electronics Technician position. The modules are:

- **Mechanical Concepts and Tools**

This section determines the applicant's knowledge of common hand tools and mechanical terminology

- **Fundamentals of Communications Electronics**

This section determines the applicant's knowledge of components, terminology, and principles required to operate, maintain, and repair radios, telephones, and digital transmission equipment.

- **Fundamentals of Computer Electronics**

This section determines the applicant's knowledge of components, terminology, and principles required to operate, maintain, and repair computer systems, including microprocessors, personal computers, peripherals, and industrial mainframes.

- **Fundamentals of Industrial Electronics and Control Circuits**

This section determines the applicant's knowledge of components, terminology, and principles required to maintain and repair motor control circuits and systems common to an industrial environment.

The Skills Assessments that are required for each Technician position are shown in Table 1. Applicants for these positions must take the Basic Skills Assessment and, if required the Extended Skills Assessment. The Basic Skills Assessment consists of the same number of multiple choice test items. The number of test items in the Extended Skills Assessment varies, according to the requirements established by the hiring department for a particular position.

Table 1. Skills Assessments for each Electronics Technician Position

Electronics Technician Position	Basic Electronic Skills Assessment	Extended Skills Assessment
Automatic Fare Collection	All areas	Mechanical Concepts and Tools
Communications	All areas	Fundamentals of Communications Electronics
Computer Specialist	All areas	Fundamentals of Computer Electronics
Revenue Vehicle	All areas	Industrial Electronics and Control Circuits
Train Control	All areas	Not required

BASIC SKILLS ASSESSMENT LIST

This list of topics is not all-inclusive, but is a good measure of the skills and knowledge that an applicant must have to do well on the test.

1. Mathematics

- a. Perform simple arithmetic calculations without the use of a calculator
- b. Perform simple radix conversions
- c. Read and interpret graphs
- d. Express the values of electronic parameters using scientific notation and exponents
- e. Use the principles of Boolean Algebra to describe and simplify logic functions

2. Passive Components

- a. Identify the schematic symbol for each of the following components
 - 1) Resistor
 - 2) Capacitor
 - 3) Inductor
 - 4) Transformer

3. DC Circuit Theory

- a. Calculate the solution to simple circuit problems using the properties of passive components, Ohms Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law
- b. Determine the time constant of a RC network

4. AC Circuit Theory

- a. Calculate reactance, impedance, and resonant frequency
- b. Relate the characteristics of tuned circuits and state how these characteristics affect the operation of filters and oscillators
- c. Relate the characteristics of and applications for transformers

5. Active Components

- a. Identify the schematic symbol for each of the following components
 - 1) Diodes (Zener, Tunnel, Signal)
 - 2) Transistors (NPN, PNP and Unijunction)
 - 3) Field Effect Transistors (JFET, MOSFET, IGBT)
 - 4) Silicon Controlled Rectifier (SCR), Diac, Triac
 - 5) Operational Amplifier

6. Active Components: Operating Characteristics

- a. Determine the expected output of a simple circuit that uses active components, given a particular input.
- b. Determine the expected output of a simple defective circuit, given a particular input and device failure mode.

7. Test Equipment

- a. Demonstrate knowledge of these oscilloscope fundamentals
 - 1) Vertical sensitivity
 - 2) Horizontal sweep rate
- b) Triggering
- b. Demonstrate knowledge of the use of an oscilloscope to measure these waveform characteristics
 - 1) Frequency
 - 2) Period
 - 3) Amplitude
 - 4) Duty cycle
 - 5) Average voltage of a sine or rectangular waveform
 - 6) RMS voltage of a sine wave

8. Electromechanical Devices

- a. Analyze the operation of relays, solenoids, and contactors in electrical circuits
- b. Evaluate the use of relays as logic elements in control applications
- c. Evaluate faults in electrical circuits using basic theory of motors and generators

9. Digital Electronics

- a. Develop the Truth Tables for simple and complex logic circuits
- b. Analyze the function of a logic diagram having sequential logic elements (clocked logic)

10. Troubleshooting

- a. Trace a signal using a schematic diagram
- b. Determine the output of a complex network, given a schematic diagram and input signal characteristics

EXTENDED SKILLS ASSESSMENT LIST

Mechanical Concepts and Tools

1. Determine the proper tool to accomplish a given task
2. Determine whether calipers, micrometers, or feeler gauges are best suited for a measurement, given an example of a situation requiring a measurement device.
3. Determine the direction and rate of rotation of a shaft, given a particular arrangement of pulleys or gears

Fundamentals of Communications Electronics

1. Identify transmission characteristics of copper cables
2. Recognize common terms associated with the operation and maintenance of digital transmission systems
3. Recognize common terms and practices associated with the operation and maintenance of FM transceivers
4. Identify the characteristics of these modes of communications
 - a. Simplex
 - b. Half duplex
 - c. Full duplex
5. Relate the functions of each layer of the OSI Model.

Fundamentals of Computer Electronics

1. Identify components such as UART, Static RAM, and Dynamic RAM, from their functional descriptions.
2. Relate the functional definitions of computer terminology, such as Memory-mapped I/O, Interrupt, and Analog-to-Digital Conversion.
3. Describe the operational instruction to a Personal Computer, given the DOS command.
4. State the functions of the input and output expected at a PC Port, given its name, such as COM 1.

Industrial Electronics and Control Circuits

1. Recognize common terms associated with controls and electronics in an industrial environment, including motor control circuits and power electronics.
2. Identify the schematic symbols of components common to Industrial Electronics.

SAMPLE QUESTIONS

This section contains several sample questions similar to those on the Basic Skills Assessment. The answers to these sample questions are on the last page of this Study Guide.

1. Refer to Figure 1. What is the total resistance between Terminals A and B?

- A. 15.2 k Ω
- B. 24 k Ω
- C. 34 k Ω
- D. 44 k Ω

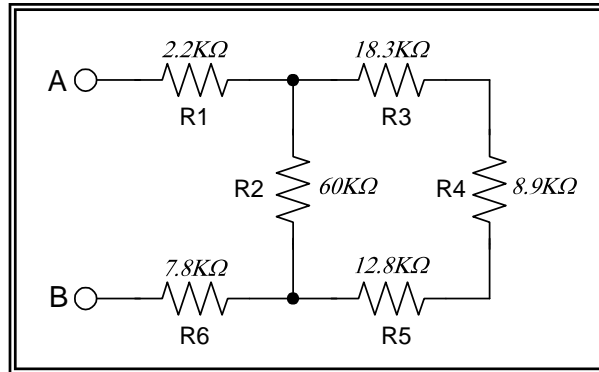


Figure 1

2. Refer to Figure 2. What is the regulator's expected output voltage (V_{R_L})?

- A. 4.5 Volts
- B. 5.0 Volts
- C. 5.5 Volts
- D. 8.5 Volts

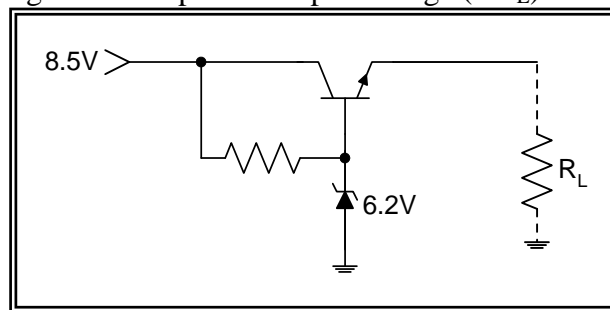
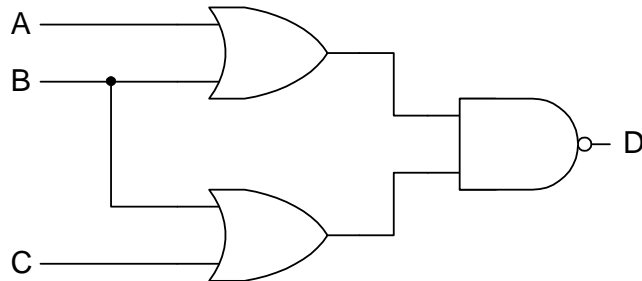


Figure 2

3. A circuit that converts DC voltages to data that a microprocessor can use is a/an:

- A. Universal Asynchronous Receiver / Transmitter.
- B. RS-422C interface.
- C. Analog-to-Digital Converter.
- D. Digital-to-Analog Converter.

4. Complete the truth table for the logic circuit shown in Figure 4.



A	B	C	D
L	L	L	
H	L	L	
L	H	L	
H	H	L	
L	L	H	
H	L	H	
L	H	H	
H	H	H	

Figure 4

5. Inductance is defined as the property of an electrical circuit that opposes any change in _____.
6. In the circuit shown in Figure 6, what is the purpose of D1?

- A. AC rectification
- B. Level shifting
- C. Negative feedback
- D. Reverse voltage clamp

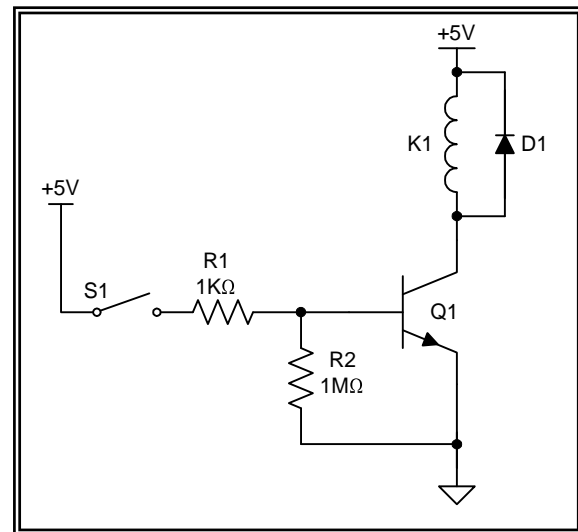
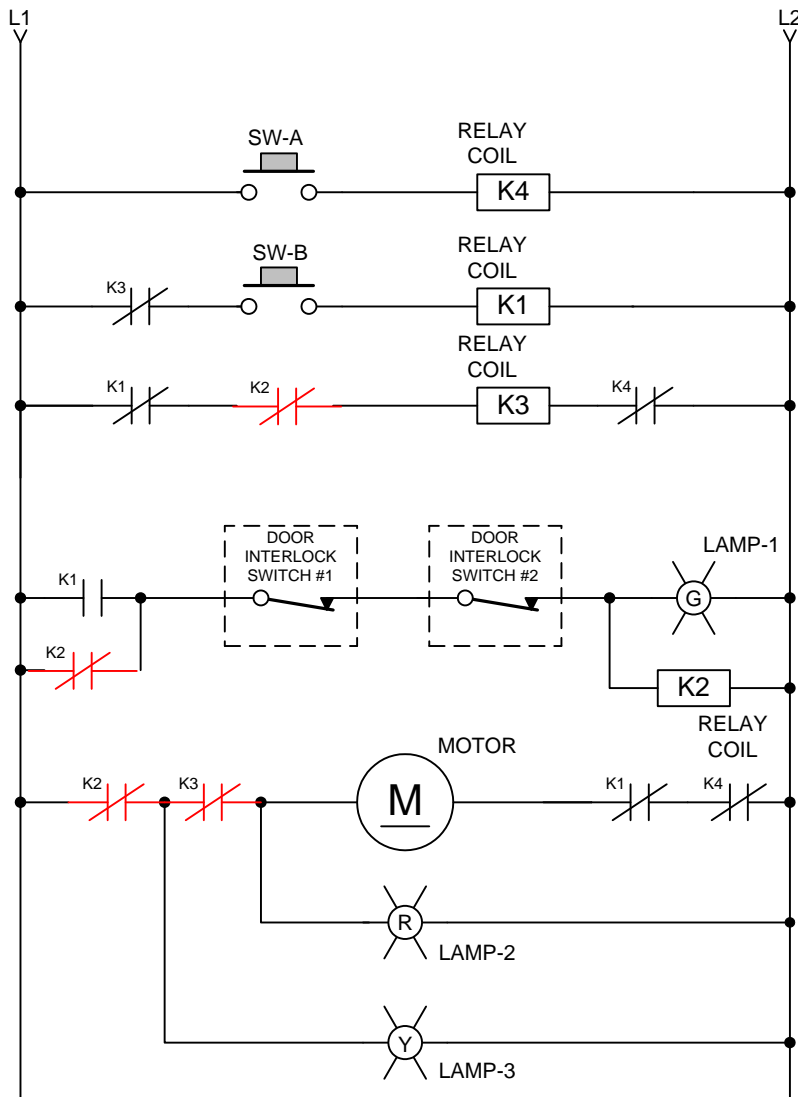


Figure 6

Figure 7



7. Refer to Figure 7. Motor, M, is energized and running. When **SW-A** is activated, the motor stops. What effect does activating **SW-A** have on the indicator circuits?
- All the indicators go out.
 - The green lamp (G) remains on, and the red (R) and yellow (Y) lamps go out.
 - The green lamp (G) goes out, and the red (R) and yellow (Y) lamps remain on.
 - The red lamp (R) goes out, and the green (G) and yellow (Y) lamps remain on.

References

These reference materials can assist in preparing you for the Electronics Technician Pre-employment Test, but they are not substitutes for extensive formal education and training in electronics. The following books contain information on the topics in the Basic Skills Assessment. The books are currently in print. You may choose books of your own to study, since any good electronics textbook contains the required information.

Electronic Communication. Robert L. Shrader. McGraw-Hill Inc.
ISBN: 0 0705 7157 0

CET Examination Book. Dick Glass and Ron Crow. TAB Books.
ISBN: 0 8306 4068 1

Practical Electronics Handbook. Ian Sinclair. Newnes.
ISBN: 0 7506 2168 0

Additionally, a wealth of technical information and listings of other resources is available through the Internet.

www.eta-sda.com. The Electronics Technicians Association, in affiliation with the Service Dealers Association, promotes training in electronics industry standards, troubleshooting techniques, test equipment knowledge, and installation procedures.

www.maintenanceresources.com/Bookstore/. This site provides definitions, formulas, quizzes, Tricks of the Trade, and downloads. It has links to manufacturers in the electronics industry, as well as to a substantial list of technical books.

www.narte.org. The National Association of Radio & Telecommunications Engineers, Inc. is a worldwide, non-profit, professional organization of engineers and technicians.

www.iscet.org. The International Society of Certified Electronics Technicians (ISCET) trains, prepares, and tests technicians in the electronics and appliance service industry.

www.tpub.com/doeelecsience/. Integrated Publishing is a resource website for technical works, including select government and military training publications.

Answers to SAMPLE QUESTIONS

- 1 – C
- 2 – C
- 3 – C
- 4 – H/H/L/L/H/L/L/L
- 5 – Current
- 6 – D
- 7 – D